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Development of GIS-Based Decision Support System for Optimizing Transportation Cost in Underground Limestone Mining

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In mining industry, large amount of cost has been invested in early stages of mine development such as prospecting, exploration, and discovery. Recent changes in mining, however, also raised the cost in operation, production, and environmental protection because ore depletion at shallow depth caused large-scale, deep mining. Therefore, many mining facilities are installed or relocated underground to reduce transportation cost as well as environmental pollution. This study presents GIS-based decision support system that optimizes transportation cost from various mining faces to mine facility in underground mines.

The development of this system consists of five steps. As a first step, mining maps were collected which contains underground geo-spatial informations. In mine maps, then, mine network and contour data were converted to GIS format in second step for 3D visualization and spatial analysis. In doing so, original tunnel outline data were digitized with ground level, and converted to simplified network format, and surface morphology, contours were converted to digital elevation model (DEM). The next step is to define calculation algorithm of transportation cost. Among the many component of transportation cost, this study focused on the fuel cost because it can be easily estimated if mining maps are available by itself. The cost were calculated by multiplication of the number of blasting, haulage per blasting, distance between mining faces to facility, fuel cost per liter, and two for downhill and uphill, divided by fuel efficiency of mining trucks. Finally, decision support system, SNUTunnel was implemented.

For the application of SNUTunnel in actual underground mine, Nammyeong Development Corporation, Korea, was selected as study site. This mine produces limestone with high content of calcite for paper, steel manufacture, or desulfurization, and its development is continuously ongoing to reach down to deeper calcite ore body, so the mine network is expanding vertically and horizontally increasing transportation cost. Factors related to the specification of mine blasting, gas per kilometer, and uphill, downhill speed were gathered by personal talk. Also, the location of three prospective mining faces were given with each development plan.

As a consequence of this study, a transportation cost map in underground network was calculated and it showed that the optimal site for underground facility was located on the same level of ongoing, and as well as for some time, planned mining faces. The transportation cost map also clearly showed that it has decreasing trend as the depth of the mine increases. Among these values, transportation cost of three predefined locations were investigated considering local geology, working condition, and accessibility.

In this study, GIS-based decision support system that optimizes mine haulage cost was developed and tested. This system estimated fuel cost through underground mine network, and proved that the system can provide useful information about transportation cost, either values or map. Developed system showed a case study in which site selection can be done with reasonable value. This approach can be also adopted, for further study, to compare the viability of installation of underground facility among the multiple domestic mines for cost-effective, environmental mining.